Science & Technology
Human Systems

Computational Modeling of Cognitive Processes in Plan Authoring

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TC3 Workshop: Cognitive Elements Of Effective Collaboration
(January 15-17 2002, San Diego)

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Context

Task: Plan authoring

- Intelligent system collaborates with human user
- Human is in charge; system makes recommendations

Key Assumption:

- Human has a better "big picture" understanding of the situation than does the intelligent system

Benefit:

- When the system makes a good recommendation, the user can accept rather than having to manually enter a new step in the plan.
- Faster plan authoring

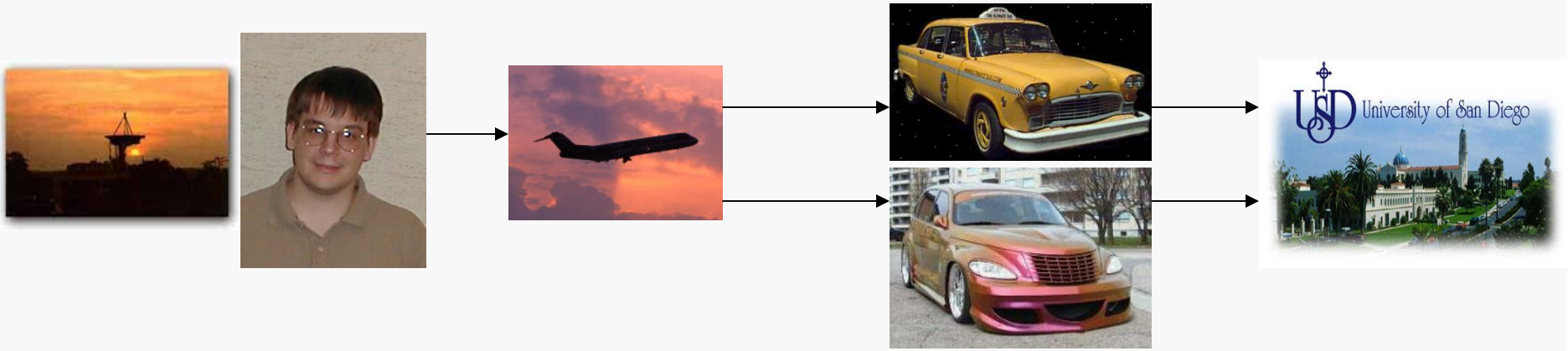
Challenge

- An intelligent system can recommend actions for a plan based on its limited knowledge.
- We are considering situations in which the human has a better general understanding of the problem.
- The recommendation the system makes will, at first, be worse than what the human can do.
- How can we get the system to improve during the course of the planning process?

Our Main Theme

1. Determine:
   a. Goals: ***what*** the user is trying to do
   b. Approach*:* ***how*** the user is trying to do it
2. Generate suggestions that are compatible with both
   – i.e., Because the user is the expert, understand the user and then do things the user's way.

<u>Goal:</u> Travel from NRL to USD



System requirement: A cognitive model of the user

Cognitive Models

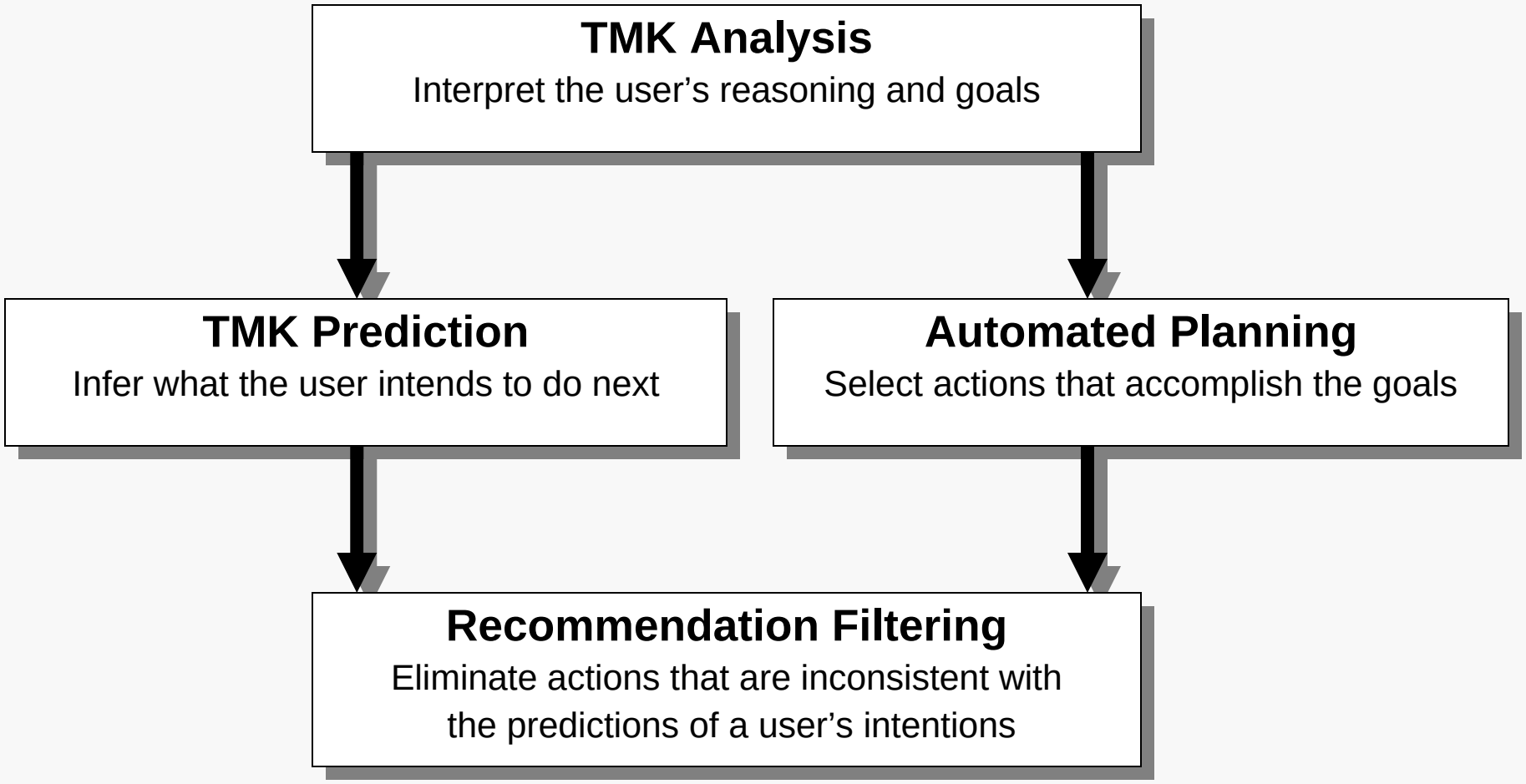
Task-Method-Knowledge (**TMK**):

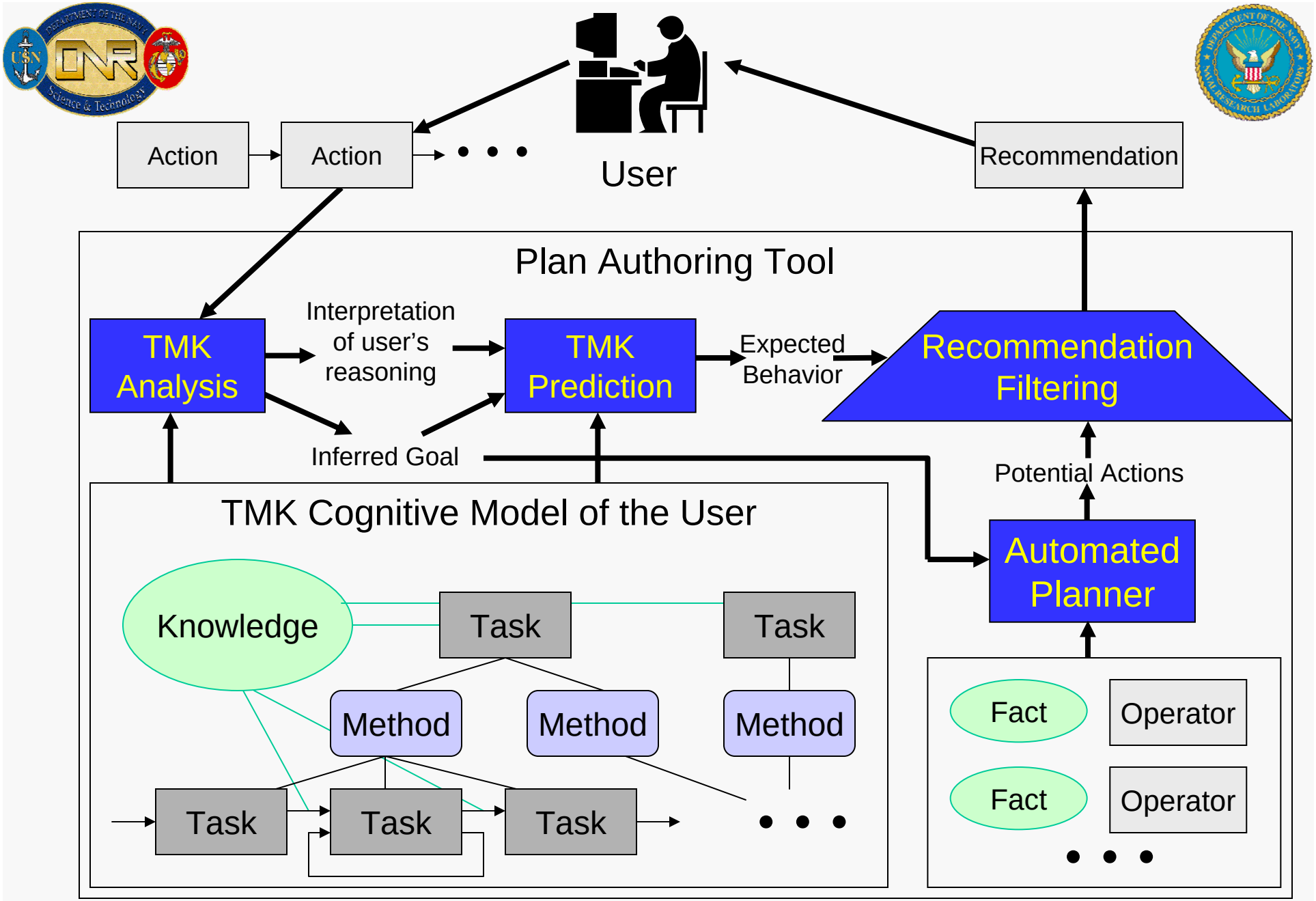
- **Tasks**: What a part of a process does.
- **Methods**: How a part of a process works.
- **Knowledge**: What the process uses and alters.

Existing work on TMK has involved:

- Intelligent systems that automatically adapt
- Executable cognitive models of recorded protocols
- Many other topics
- ***But never cognitive models of users***

Overview of Decision Making Architecture

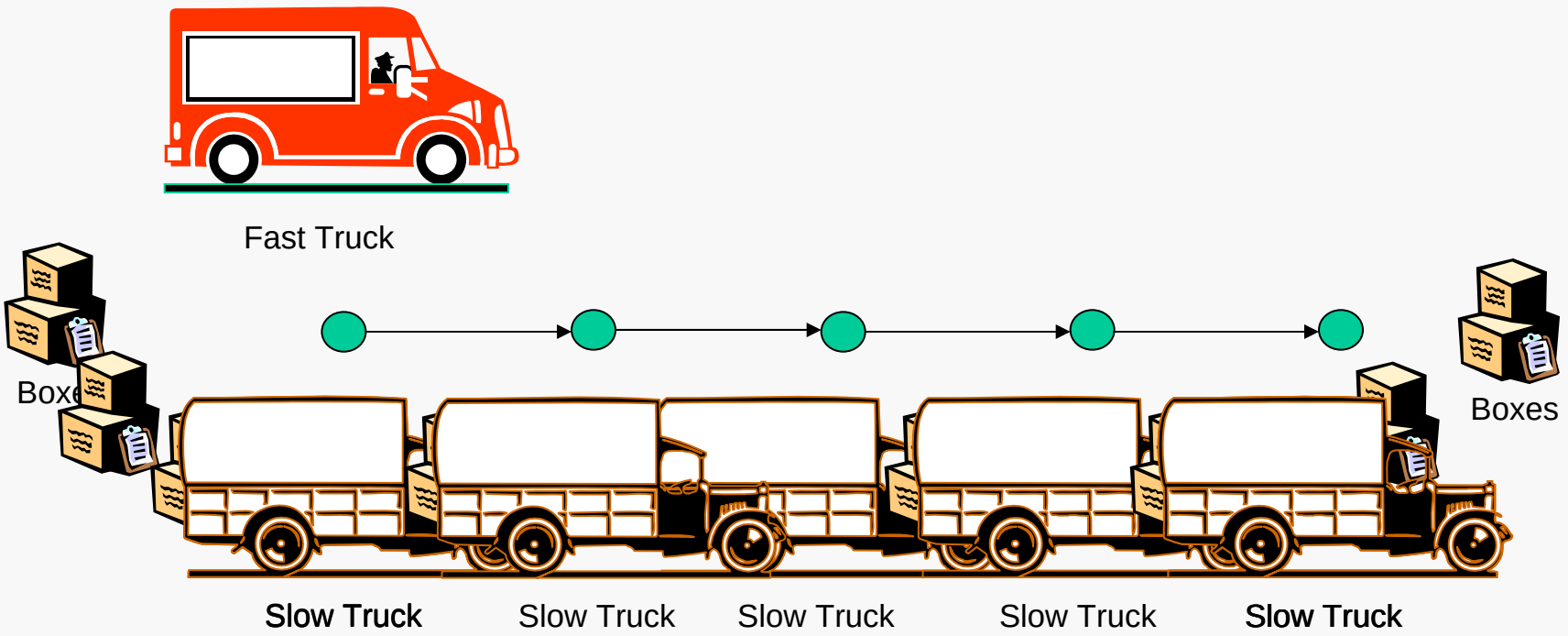



Action
Action
User
Recommendation
Plan Authoring Tool
TMK Analysis
Interpretation of user's reasoning
TMK Prediction
Expected Behavior
Recommendation Filtering
Inferred Goal
Potential Actions
TMK Cognitive Model of the User
Automated Planner
Knowledge
Task
Task
Method
Method
Method
Task
Task
Task
Fact
Operator
Fact
Operator

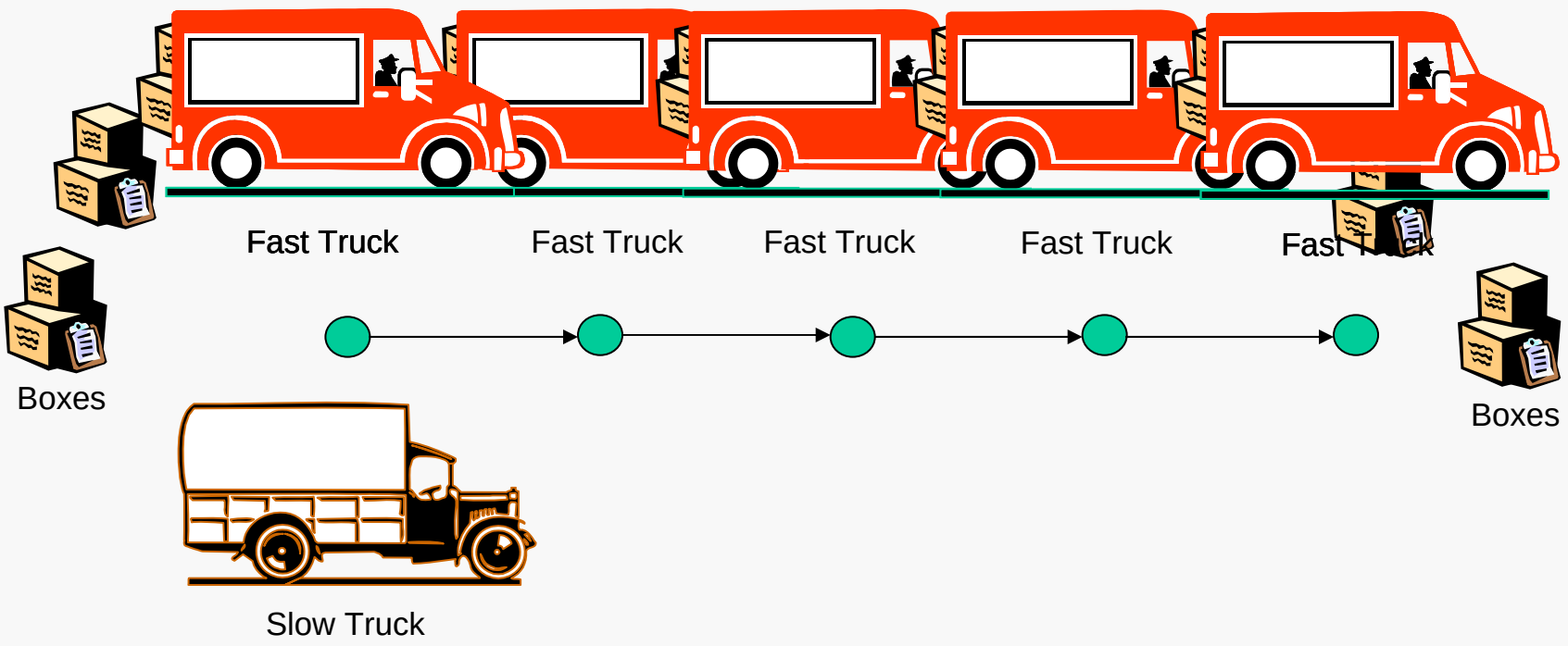
An Illustrative Logistics Example

- User has some boxes to ship and two available trucks.
- One truck is faster, so a planner will recommend it.
- The user wants to use the slower truck.
- Challenge: Recognize that the user has chosen the slower truck and make recommendations that abide by that choice.

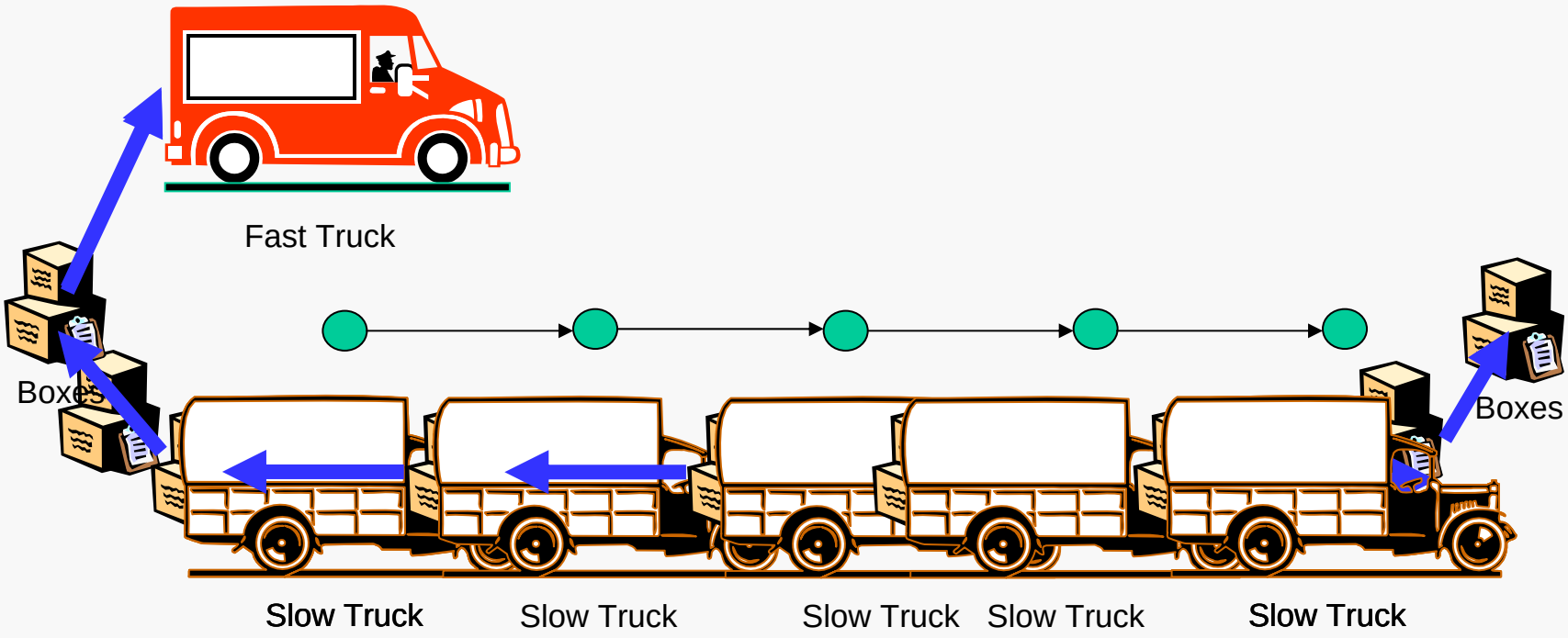
What the user wants



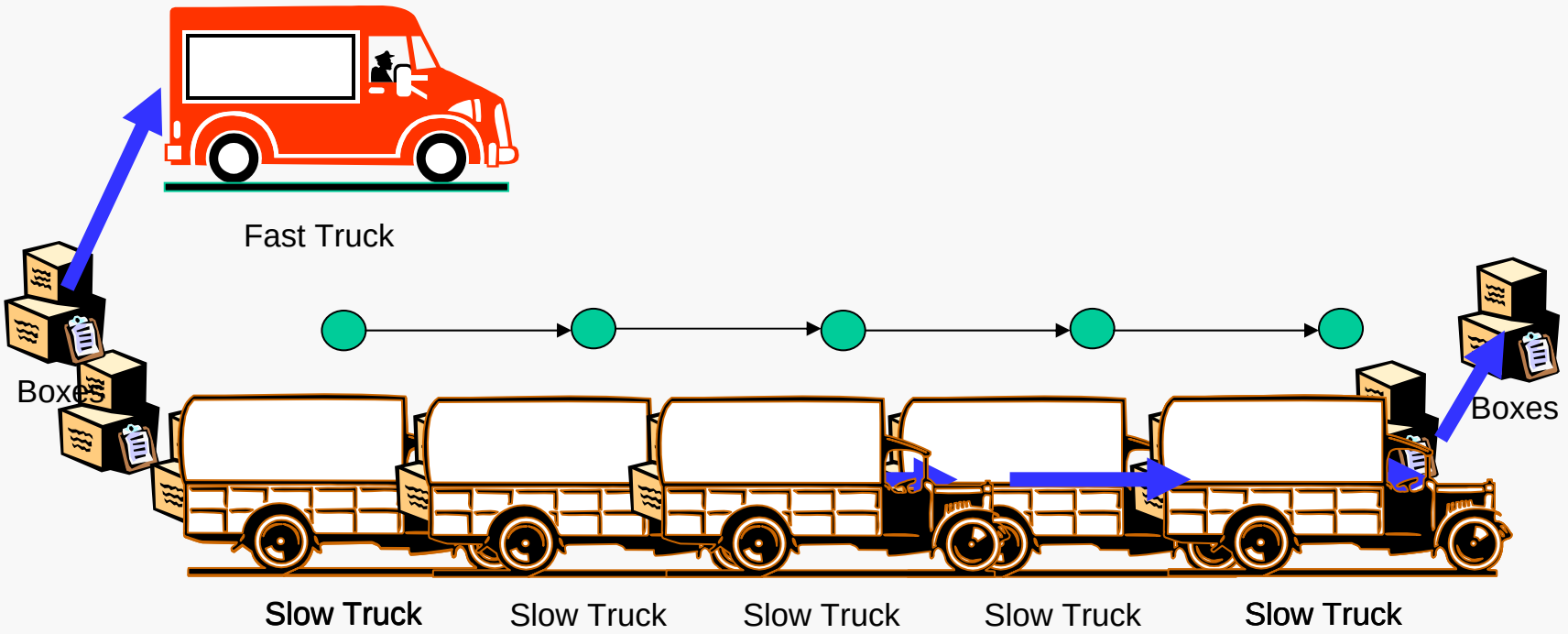
What the automated planner would do

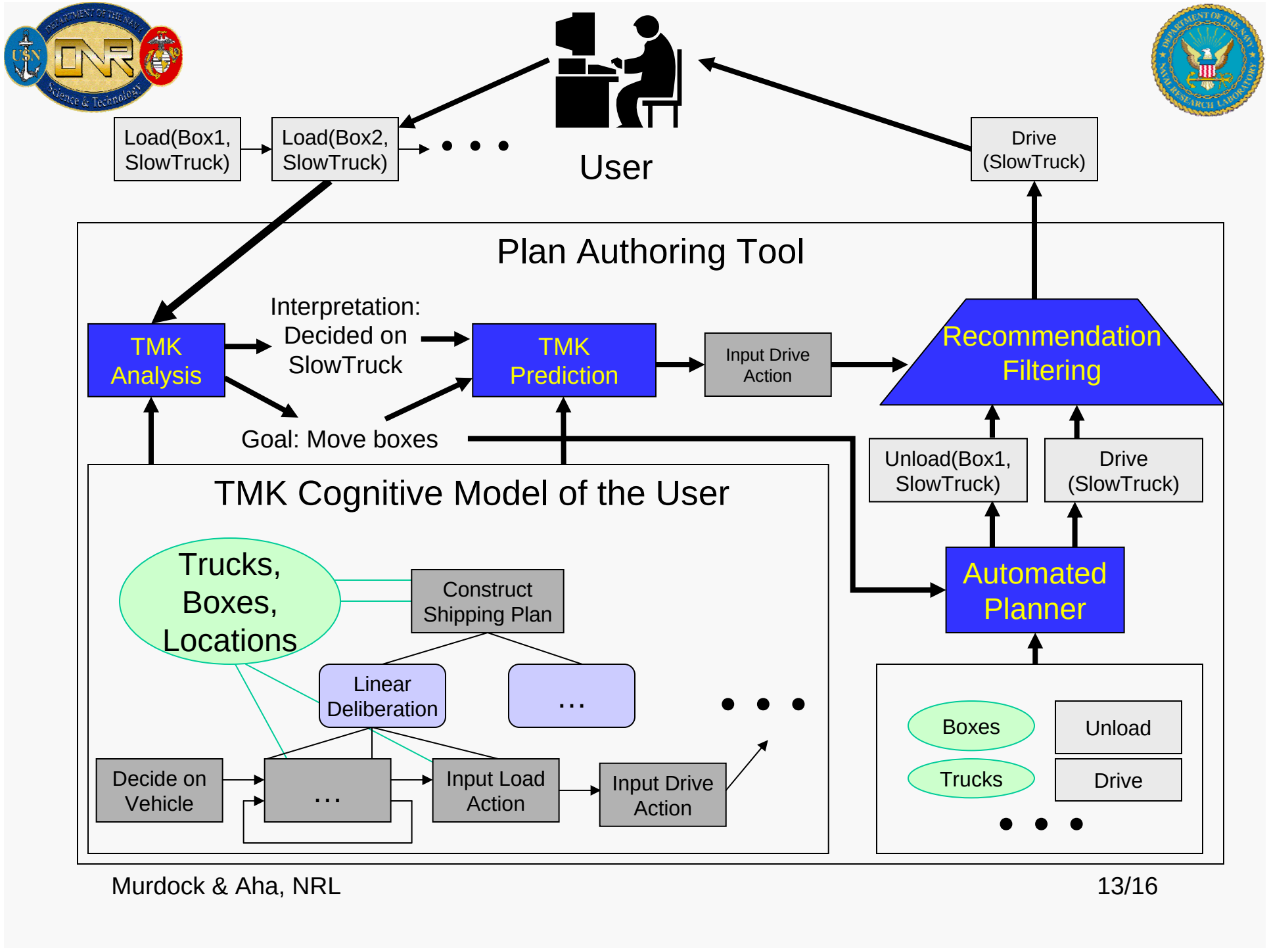


Recommendations *without* cognitive modeling



Recommendations *with* cognitive modeling




Load(Box1, SlowTruck)
Load(Box2, SlowTruck)
User
Drive (SlowTruck)
Plan Authoring Tool
TMK Analysis
Interpretation: Decided on SlowTruck
TMK Prediction
Input Drive Action
Recommendation Filtering
Goal: Move boxes
Unload(Box1, SlowTruck)
Drive (SlowTruck)
TMK Cognitive Model of the User
Trucks, Boxes, Locations
Construct Shipping Plan
Linear Deliberation
…
Automated Planner
Boxes
Unload
Trucks
Drive
Decide on Vehicle
…
Input Load Action
Input Drive Action

Domain Applicability

- Data-intensive environments
  - System can make a significant contribution
- Decisions require additional background knowledge and/or subjective judgments
  - System must collaborate with the user
- Expert human users
  - System's approach should match user's preference

- Example: Noncombatant Evacuation Operations (NEOs)
  - Tasks: Deliberative and execution-time planning
  - Data: Doctrine, SOPs, and records of past NEOs are available
  - Requires that human have final authority over decisions

Open Issues

- Is TMK adequate for modeling users?
  - If not, what augmentations are needed?
- Where do TMK user models come from?
  1. Encoded by system designers from cognitive studies?
  2. Extracted automatically through experience?
  3. A combination of (1) and (2)?
- Is information from user actions adequate for judging user intentions?
  - If not, what other information can enable coordination between the user and the system?

Summary

- Intelligent system collaborates with a human user; the system provides recommendations during plan authoring.
- Cognitive model is used to infer *what* the user wants to do and *how* the user wants to do it.
- User's cognitive model is composed of Tasks, Methods, and Knowledge (TMK)
- Proposed tool recommends actions for doing what the user wants in the way that the user wants to do it.